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Northwestern Ontario Forest Technology Development Unit

Northwestern Ontario Boreal Forest Management

Technical Notes

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ESNAGAMI BRUSHSAW STUDY: EFFECTS OF VARIOUS CONCENTRATIONS OF 2,4-D AND GLYPHOSATE ON TREMBLING ASPEN

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Release of conifers from competing hardwood vegetation is often essential during the critical years of plantation establishment to ensure survival and improve growth rates (Malik and Vanden Born 1986). Numerous hand tending tools have been developed to release conifers. The hatchet, axe, machete, girdling tools and Sandvik® are strictly mechanical, while sure-shot injectors, hypo-hatchet, Ezject® systems, backpack sprayers and brushsaw stump applicators are designed to apply a controlled amount of herbicide directly to the vascular systems of undesirable plants during release work. Each of these methods has its own advantages, disadvantages, production rates and levels of worker exposure to herbicides (Boateng and Ackerman 1990).

Manual release treatments can have many advantages. They are preferred in "Areas of Concern" such as along road corridors with high recreation use, in plantations too small for aerial applications of herbicides and in areas requiring selective release, for example, those being managed as mixedwood cover types. These manual release treatments are quite often preferred even though production rates on such operations are low (ie. ranging from 0.1 to 1.0 ha/person/day) depending upon site conditions, contract specifications and worker skill and training (Boateng and Ackerman 1990). Costs are high, as the work is labour intensive and monotonous, and risk of injury is always present. Also, due to the prolific resprouting ability of competitive species found in northwestern Ontario (Coates *et al.* 1990, Bell 1991), hand tending (without the combined use of herbicides) may have to be carried out two or three times before a plantation reaches 'free-to-grow'. Combining the use of herbicides with hand tending can greatly increase the effective time of the treatment, so that the tending operation may need to be carried out only once.

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VMAP
Vegetation Management Alternatives Program

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The introduction of stump applicators, such as the Enso (Figure 1), and the approval of systemic herbicides for forestry purposes have increased the options available for hand tending. In these operations, a small amount of herbicide is applied to the top of the stump during cutting to prevent prolific resprouting and suckering. There are five herbicides approved for forestry use that are suitable for stump treatment applications (Table 1).

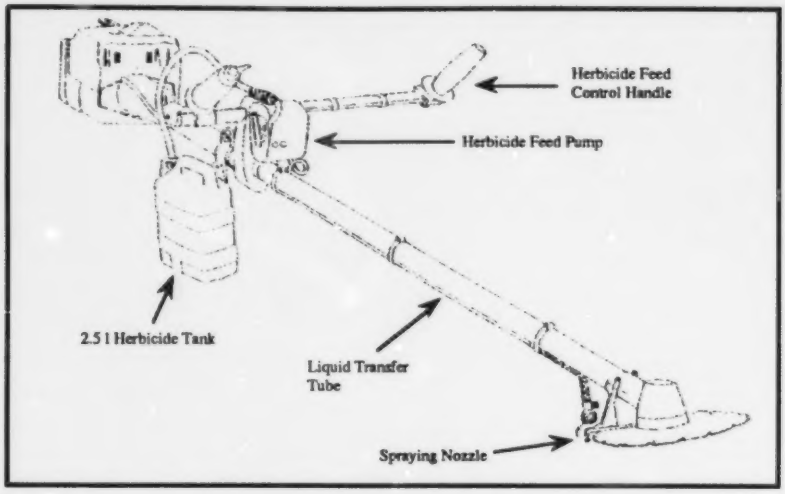

Figure 1. Brushsaw with herbicide applicator attachment.

Table 1: Herbicides approved for injection and cut stump treatment in Ontario (as of 1991).

Common Name	Trade Name (example)	Manufacturer
2,4-D (ester)	2,4-D (ester)	Various Manufacturers
Diphenoprop	Weedone CB	Rohne-Poulenc Canada Inc.
Glyphosate	Vision / Roundup	Monsanto Canada Inc.
Picloram	Tordon 101 Mixture	DowElanco Canada Inc.
Triclopyr ester	Release	DowElanco Canada Inc.

Few trials have been carried out examining stump application of herbicides. A study in Parry Sound indicated that glyphosate at a rate of 25% is effective in reducing resprouts of trembling aspen (*Populus tremuloides* Michx.), white birch (*Betula papyrifera* Marsh.) and pin cherry (*Prunus pensylvanica*) by 100% (Expert Committee on Weeds 1982). A trial in Pardee Township, Thunder Bay District, achieved a complete kill of hardwood species with a 20% solution of glyphosate and partial kill with a 10% solution (Bons 1984). Similar studies in New Brunswick and Ontario found at least 94% control of sugar maple (*Acer saccharum* Marsh), birch (*Betula* spp.), aspen (*Populus* spp.) and pin cherry with 3.3% solutions of triclopyr ester applied as cut stump treatments (Expert Committee on Weeds 1982,1983,1989).

Although these studies involved the use of glyphosate and triclopyr ester, the other herbicides listed should not be discounted. While the application of herbicides is only recommended where their use is the best alternative, selection of the proper herbicide for application purposes should be based on its effectiveness when applied at the proper time and rate.

This technical note describes the effects of three rates of 2,4-D and four rates of glyphosate (Roundup®) on aspen, one and seven years after treatment.

OBJECTIVES

In 1984, the Geraldton District of the Ontario Ministry of Natural Resources purchased brushsaws and stump applicators for operational hand tending purposes. A study was initiated to:

1. Compare the effectiveness of Roundup® and 2,4-D as a method of stump treatment.

2. Study the effect of various concentrations of Roundup® and 2,4-D on undesired competition.

METHODS

Location and Description of Experimental Site

The study area is located northwest of Nakina, Ontario in the Esnagami Road Reserve (Base Map # 503864, Figure 2). This area was chosen due to its overall uniform regeneration and competition densities. The soil in the area is a deep, well-drained, sandy loam with very few surface boulders. The original stand, a white birch working group, was logged using the conventional cut and skid method in 1978. The site was scarified in 1979

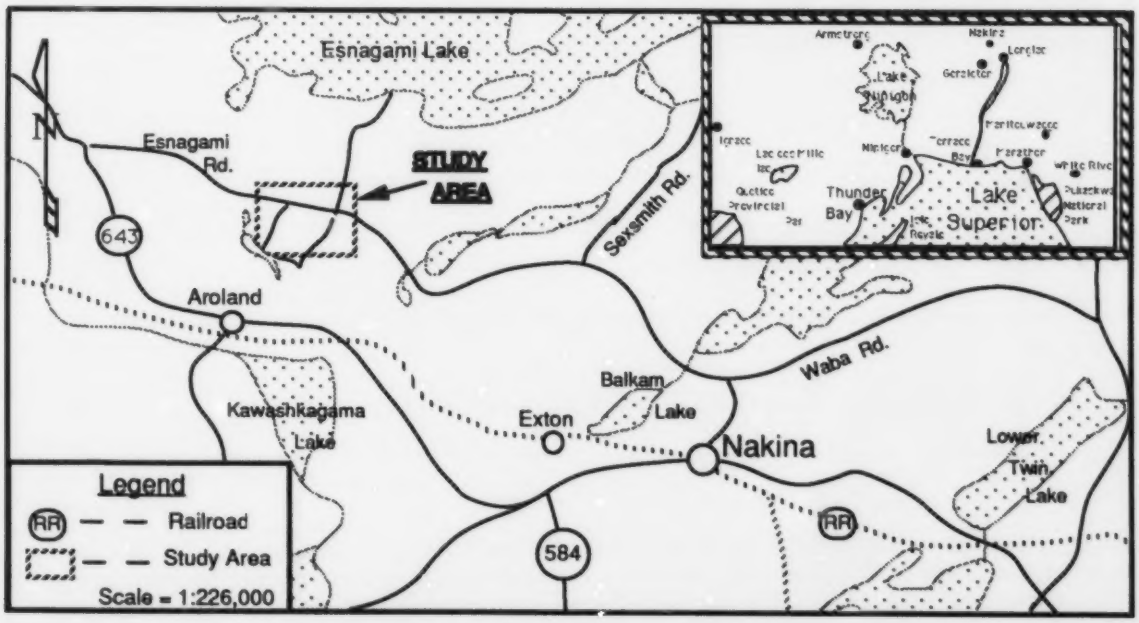

Figure 2. Esnagami brushsaw study area.

by bulldozers pulling barrels and chains and planted the following spring with black spruce (*Picea mariana* (Mill) B.S.P.) 1+2 bareroot stock. At the initiation of this study four years later, the plantation was in need of tending. The desired species (black spruce and jack pine (*Pinus banksiana* Lamb.)) had an average height of 0.5 m, while the competitive species (aspen, birch and willow (*Salix* spp.)) had an average height of approximately 2.5 m.

Experimental Design

In late July 1984, ten treatment plots (10 m x 20 m) were established. Ten subplots (2 m x 2 m) were systematically located near the centre of each plot, as shown in Figure 3. This provided a treatment zone around the subplots to minimize the possibility of herbicides translocating to adjoining subplots through the root systems of adjacent stems. Prior to treatment, each tree and shrub in each subplot was tallied where it protruded from the soil. The equipment used for the experiment were Sandviks® and Jonsered RS45® brushsaws mounted with T.T. Painesirppi® Stump Sprayers. Experienced brushsaw operators mixed the herbicides and carried out the release work on each plot.

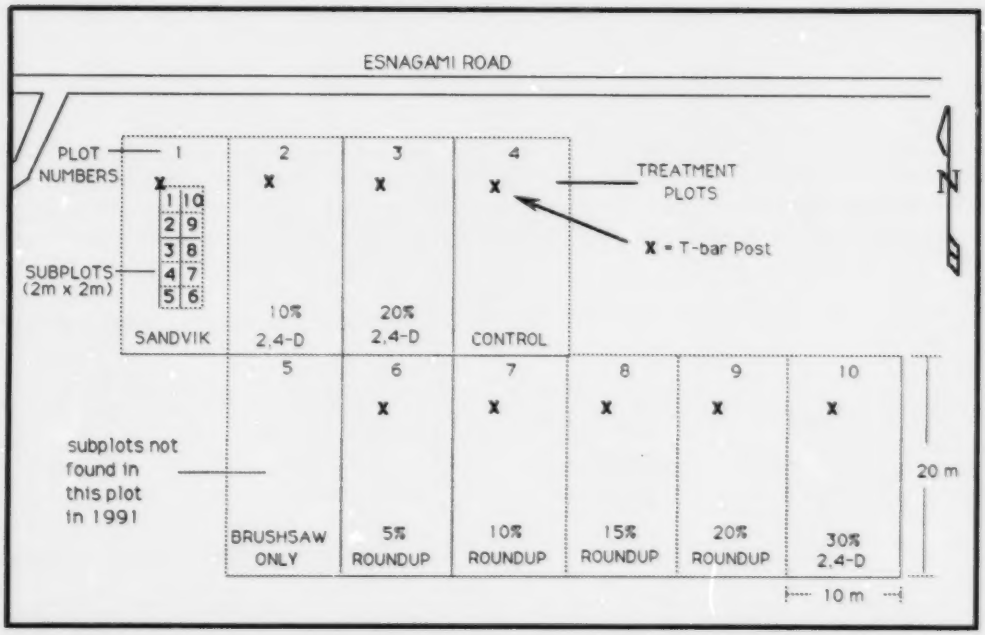

Figure 3. Treatment block layout of Esnagami brushsaw study area.

Roundup®, with an active ingredient of 356 grams of glyphosate per litre of solution, and 2,4-D with an acid equivalent of 600 grams per litre of solution were used. Roundup® solutions were mixed with water to obtain concentration rates of 5, 10, 15 and 20 percent; 2,4-D solutions were mixed with water for concentrations of 10, 20 and 30 percent. A few drops of rhodamine dye were added to each solution to enable identification of the treated stumps.

Four plots were brushsawed and stump treated simultaneously with Roundup® at concentrations of 5, 10, 15

and 20 percent. Three plots were brushsawed and stump treated simultaneously with 2,4-D at concentrations of 10, 20 and 30 percent. One plot was cleared using brushsaws with no herbicide application. One plot was cleared using Sandviks® to produce a three quarter cut (ie., stems were cut 3/4 of the way through and then bent over to retard growth and resprouting vigour). One plot, the control, was not cleared of competition. Tending was not carried out on days when rain was forecast to avoid having the herbicide washed off the stumps before it could be absorbed. The tending crews were instructed to be sure that the stem cuts were located below the lowest living branch. This is most important when using Sandviks® to produce 3/4 cuts in order to retard growth.

In October 1991, as an extension to this project, sample aspen, visually representative of the trees in the plot, were collected from the buffer of each treatment plot. These aspen were examined for any growth patterns or stem rot that could be linked to the various treatments.

Data Analysis

In 1985 and again in 1991, every live tree and shrub was tallied in each subplot of the treatment plots. A statistical analysis could not be conducted because there were no replications from which to derive an error sum of squares. Therefore, data analysis was based on recorded data, ie: actual numbers of resprouts, percent of resprouts and recorded average heights of spruce and aspen on the subplots. Data for 1991 were not available for the brushsaw only plot as the subplots could not be relocated.

Table 2: Number of aspen stems before treatment (July 1984) and one year (1985) and seven years (1991) after treatment.

Treatment	Number of Stems Before Treatment (B)	Number of Stems After Treatment (A)		Percent Resprouting (A/B X 100)	
	1984	1985	1991	1985	1991
Control	59	59	19	100	32
Sandvik	62	76	26	123	42
Brushsaw Only	147	160	n.a.	109	n.a.
2,4-D 10%	48	38	15	79	31
2,4-D 20%	101	4	8	4	8
2,4-D 30%	145	69	53	48	37
Roundup 5%	120	3	23	3	19
Roundup 10%	89	14	21	16	24
Roundup 15%	110	12	28	11	25
Roundup 20%	72	13	33	18	46

n.a. : Data Not Available

RESULTS

Prior to the release treatments there were substantial differences between the plots in the number of competitive stems present. In an attempt to balance these differences, treatment effects are described as the percent resprouting after treatment (ie. number of resprouts divided by original number of stems x 100). There were too few birch stems to warrant comparison. However, there were sufficient numbers of aspen stems with substantial differences between the plots to ascertain treatment effects, as presented in Table 2.

Observations one year after treatment:

a) Stumps in the Sandvik® and brushsaw (without herbicides) plots resprouted prolifically (Figure 4).

b) Use of Sandviks® and brushsaws (without herbicides) was effective in reducing the height of the competition but not the number of stems.

c) Stumps in the 2,4-D plots showed some signs of resprouting (Figure 4).

d) Stumps in the Roundup® plots showed minimal evidence of resprouting (Figure 4).

e) In each of the chemically treated plots all competitive species appeared to be equally susceptible to the herbicides.

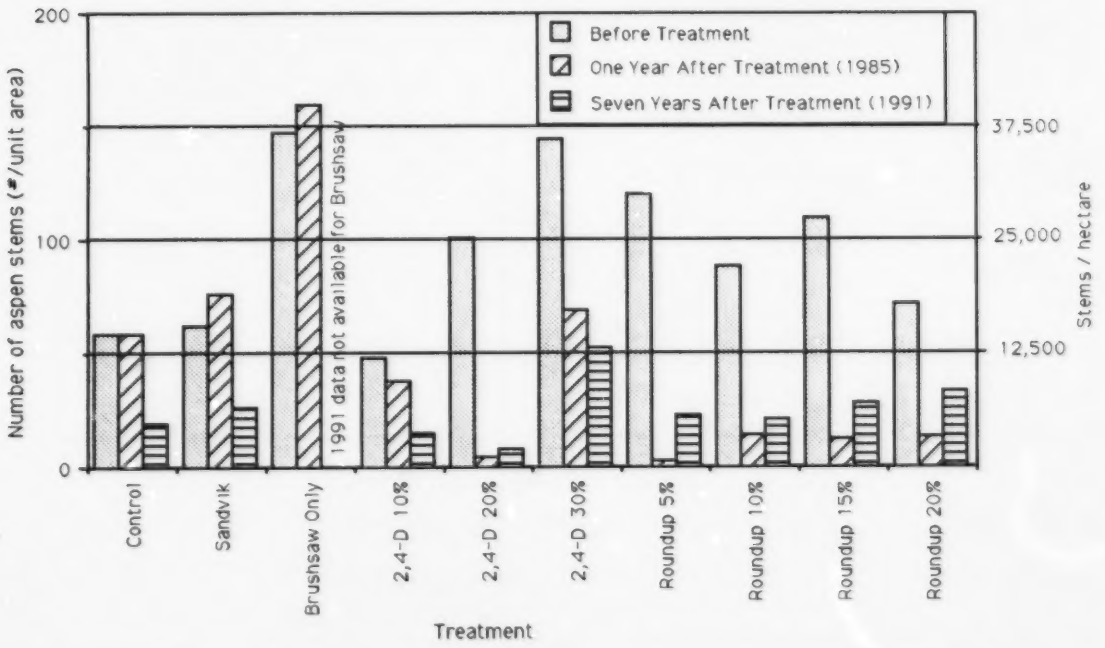

Figure 4. Resprouts of aspen one year and seven years after treatment.

Observations seven years after treatment:

a) The actual number of aspen stems appear to be stabilizing at around 6,300 stems/ha on most of the plots (Figure 4).

b) The average height of spruce in all but two of the plots (control and 5% Roundup®) is taller than the average height of the aspen (Figure 5).

c) The effectiveness of the 10 percent solution of 2,4-D, while not dramatic, was sufficient to have maintained control of resprouting. The number of resprouts in the plot treated with the 30 percent solution of 2,4-D is one third the original number, but is still the highest count of all plots. Overall, 2,4-D treatments have significantly reduced the number of competing stems seven years after treatment, while increasing spruce growth above average aspen height (Figure 5).

d) The average height of aspen resprouts on all three of the 2,4-D plots is the lowest of all the treatments (Figure 5).

e) The success of 2,4-D at the 20 percent rate is questionable. Based on the results of the other treatments in this trial "application error" is thought to have caused the apparent discrepancy in results.

f) Roundup® appeared to be equally successful at all rates, but seven years after treatment numbers of aspen stems on the plots are starting to increase (Figure 4). This might not be a problem since the average height of the spruce on three of the four Roundup® plots is still greater than the aspen.

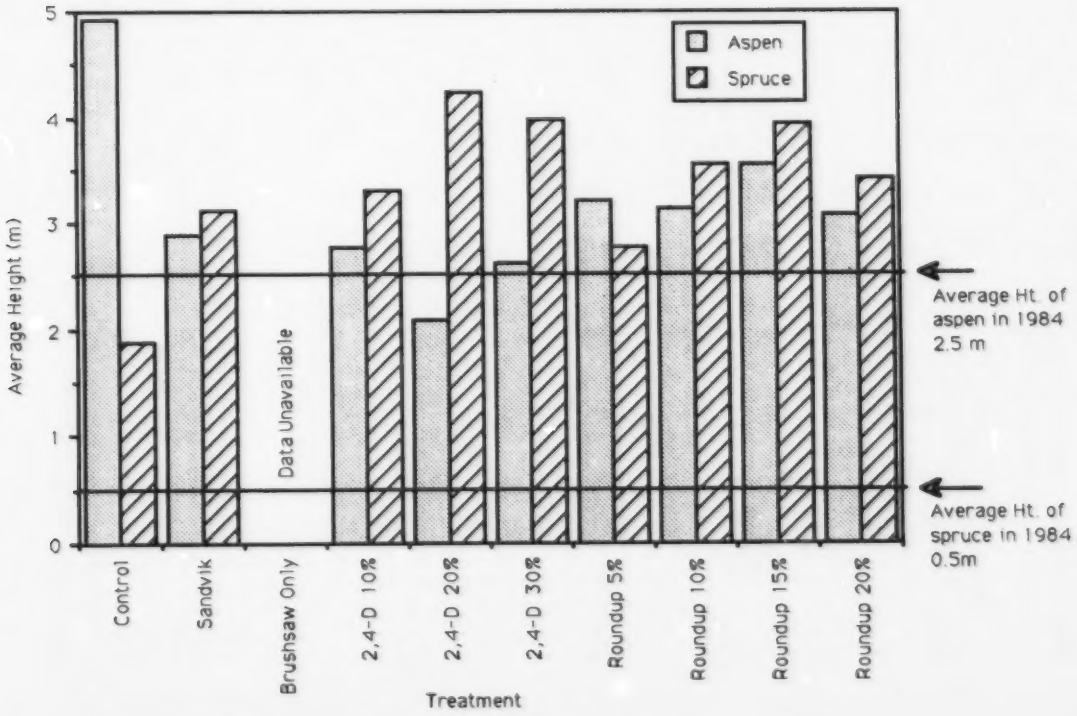

Figure 5. Average height (m) of crop species and competition in 1991.

g) Although the Sandvik® treatment may have resulted initially in high levels of resprouting, the 3/4 cut treatment appears to have been successful at retarding the vigour of the new sprouts as illustrated in Figure 5 where the heights of the target species and competition in the Sandvik® plots are similar to the Roundup® treatments.

The representative aspen collected from each treatment plot were examined for original stump degradation and stem rot. The lower 60 cm of each stem was cut in half lengthwise for this examination. For the brushsaw only treatment and all three of the 2,4-D plots, the resprouts showed that they had grown up and around the non-rotted original stump. All four of the Roundup® samples revealed cleaner resprout stems suggesting they resprouted from lower on the stump, at the root collar or from the roots. This would indicate that the Roundup® was absorbed deeper into the cut stump than the 2,4-D. Table 3 shows the recorded measurements for these trees and Figure 6 shows the stem comparisons.

Table 3: Sample aspen collected in October 1991 to examine for stem rot and growth patterns attributable to treatments.

Plot #	Treatment	Height (m)	DBH [1] (cm)	DRC [2] (cm)	Aspen 1991 Average Height	Aspen 1991 Average DBH
4	Control*	a. 5.80 b. 7.00	3.21 4.93	3.85 6.10	4.92	3.00
1	Sandvik*	a. 4.05 b. 6.30	2.71 4.57	5.51 6.31	2.89	1.83
5	Brushsaw	4.11	2.85	4.61	n.a.	n.a.
2	10% 2,4-D	4.37	3.05	4.51	2.77	1.65
3	20% 2,4-D	2.45	1.68	4.32	2.11	1.31
10	30% 2,4-D	4.27	2.56	3.31	2.63	1.43
6	5% Roundup	3.25	2.51	3.75	3.21	1.96
7	10% Roundup	3.85	2.67	4.69	3.14	2.17
8	15% Roundup	3.52	1.98	2.91	3.56	2.22
9	20% Roundup	4.53	2.71	4.45	3.08	2.21

* : Two sample trees collected
n.a. : Data not available
1 : DBH = Diameter breast height
2 : DRC = Diameter root collar

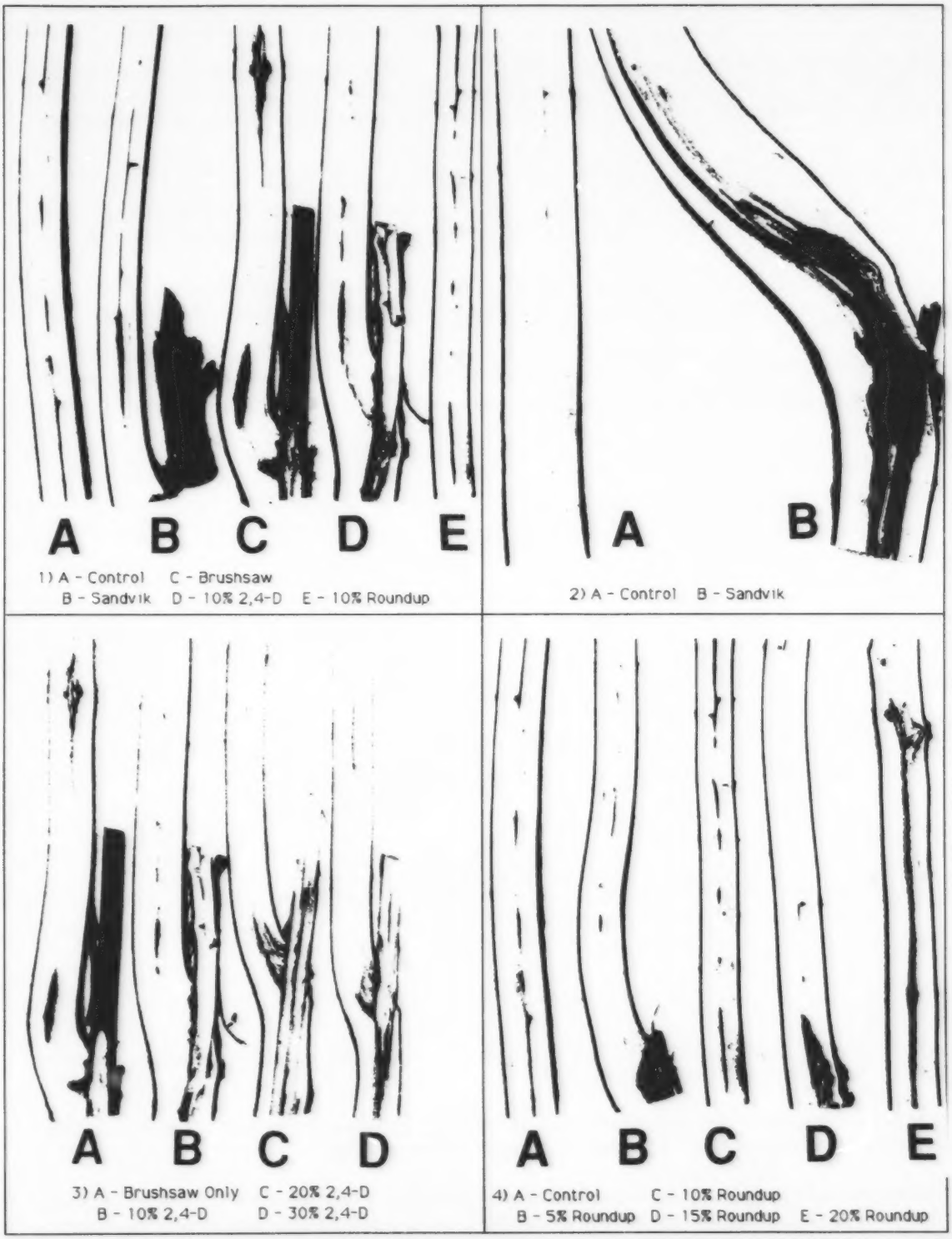
A B C D E
1) A - Control C - Brushsaw
B - Sandvik D - 10% 2,4-D E - 10% Roundup
A B
2) A - Control B - Sandvik
A B C D
3) A - Brushsaw Only C - 20% 2,4-D
B - 10% 2,4-D D - 30% 2,4-D
A B C D E
4) A - Control C - 10% Roundup
B - 5% Roundup D - 15% Roundup E - 20% Roundup

Figure 6. Cross sections of representative aspen suckers from treatments in Esnagami brushsaw study: 1) assorted treatments, 2) controls vs. Sandvik®, 3) brushsaw vs. 2,4-D, and 4) control vs. Roundup®.

DISCUSSION

All the chemical treatments, as well as the Sandvik® only treatment, were effective in controlling (not eliminating) aspen growth. This has not only allowed the spruce and jack pine to gain height growth, thereby meeting free-to-grow objectives sooner, but has provided several years of available browse in the plantation area.

The increasing number of resprouts at the higher herbicide concentration levels (ie: 30% 2,4-D and 20% Roundup®) may be the result of an overly quick kill of the tissue cells in the stumps. This quick kill slows absorption of the herbicide, while lower application rates allow more time for translocation of the herbicide into the stump and roots.

CONCLUSIONS

Comparing the results after one and seven years, the treatments can be divided into three groups, based on effectiveness, as shown in Table 4.

Table 4: Subjective relative rankings of treatment effectiveness at the Esnagami brushsaw study.

Effectiveness	1985	1991
Least	Control Sandvik Brushsaw	Control
Moderate	10% 2,4-D 30% 2,4-D	Sandvik 30% 2,4-D 20% Roundup
Highest	5% Roundup 10% Roundup 15% Roundup 20% Roundup	10% 2,4-D 5% Roundup 10% Roundup 15% Roundup

20% 2,4-D plot not ranked due to possible application errors.
Brushsaw plot not ranked for 1991 as data not available.

Roundup® applied at concentrations of 5, 10 and 15 percent and 2,4-D applied at 10 percent concentration appeared to be the most effective treatments in this trial.

2,4-D as a stump treatment, did not control the actual number of resprouts, but was most effective in reducing height growth of the resprouts, allowing crop trees to gain additional height.

Brushsaws (without herbicide application) reduced the amount of competition during the growing season that treatment was applied, but prolific resprouting the following season increased the amount of competition on that plot.

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